GEOLOGICAL DATABASE OF İSTANBUL

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ABSTRACT

As a part of the Seismic Risk Evaluation Program in Istanbul a geological database is developed to support geological and geotechnical analysis works for the study area. The database consists of three parts: data input, query functions and data display. Queries are performed in accordance with coordinates defining the query area, formation name, major soil type, detail soil type and two selected items in the list containing soil and rock laboratory test types and PS loggings. Data display means creating strip logs and cross-sections. The software components of the system are MS Access for data storage, RockWorks99 for data display, ArcView for representing boreholes on the maps and a specific program developed for this project with MS Visual Basic and named GeoData. Query and data display functions connecting the database to RockWorks99 and ArcView are included in GeoData.

1 INTRODUCTION

In Istanbul, many existing borehole data, including borehole logs and laboratory tests are available. All of these data are printed documents and data format is different with each other. For example,

- data (e.g. values of TCR, blow count, length of penetration, etc.) is numerical or on the graphics,
- names or abbreviations are used for data types (e.g. Undisturbed or U) ,
- different abbreviations are used for the same data type (e.g. U and UD as undisturbed),
- soil types and formations are defined with abbreviations, names or explanations (e.g. FL or Fill),
- patterns and/or explanations are used for soil types,
- boundaries of soil types are shown explicitly or not,
- in some caseses, start, end or length of some tests are not explicit,
- numerical values or explanations are given for some data types (e.g. degree of weathering),
- Turkish and/or English are used,
- graphics are scaled or not,
- test results are given on the graphics or in extra tables,
- documents are original or photocopy.

However there are some problems related to appearence or contents of the documents. For example,

- photocopies may be illegible,
- end of the borehole may be greater or smaller than the value given as total depth.

The aim of this project is not only to store borehole data into databases in unified format but also to apply them for various geological and geotechnical analyses purpose as a part of Seismic Risk Evaluation Program in Istanbul. Therefore, not only a database program is used but also a specific program named GeoData is developed with MS Visual Basic 6.0 and two more commercial programs are used. These are described in the following in detail.

2 DETAIL STRUCTURE OF THE DATABASE SYSTEM

Figure 1 shows overall framework and the flow chart of the database. While solid arrows indicate the next step in each program, dot arrows indicate the sources and the relations between the programs. In the following, the database system is described in accordance with its functions.

Each borehole data are stored each MS Access database which is named in accordance with reference number of each borehole. There is only one table, which is named "input", in each database. Table name is unique. Input table contains 45 fields. Borehole data is manually extracted from the graphics, tables and the explanations on the documents. The followings are the input items:

Header information
- Reference no
- Project name (client, contractor, locality, etc.)
- Borehole no
- Boring depth (m)
- Coordinate x and y (UTM: Universal Transversal Marcator)
- Elevation (m)
- Date of drilling

Soil types and their boundary depths
- Lower depth (GL-m: from Ground Level-meter)
- Major soil type
- Detail soil type

Formation names and their boundary depths
- Lower depth (GL-m)
- Formation name

Rock conditions and their boundary depths
- Lower depth (GL-m)
- TCR value
- RQD value
- Degree of weathering

Results of standart penetration tests
- Upper depth of sample (GL-m)
- Lower depth of sample (GL-m)
- First blow count
- First length of penetration (cm)
- Second blow count
- Second length of penetration (cm)
- Third blow count
- Third length of penetration (cm)
- N value
- Length of penetration (cm)
- Corelated N value

Results of soil laboratory tests
- Upper depth of sample (GL-m)
- Lower depth of sample (GL-m)
- Gravel contents (%)
- Sand contents (%)
- Fine contents (%)
- D10 mm
- D20 mm
- D30 mm
- D50 mm
- D60 mm
- Liquid limit (LL) (%)

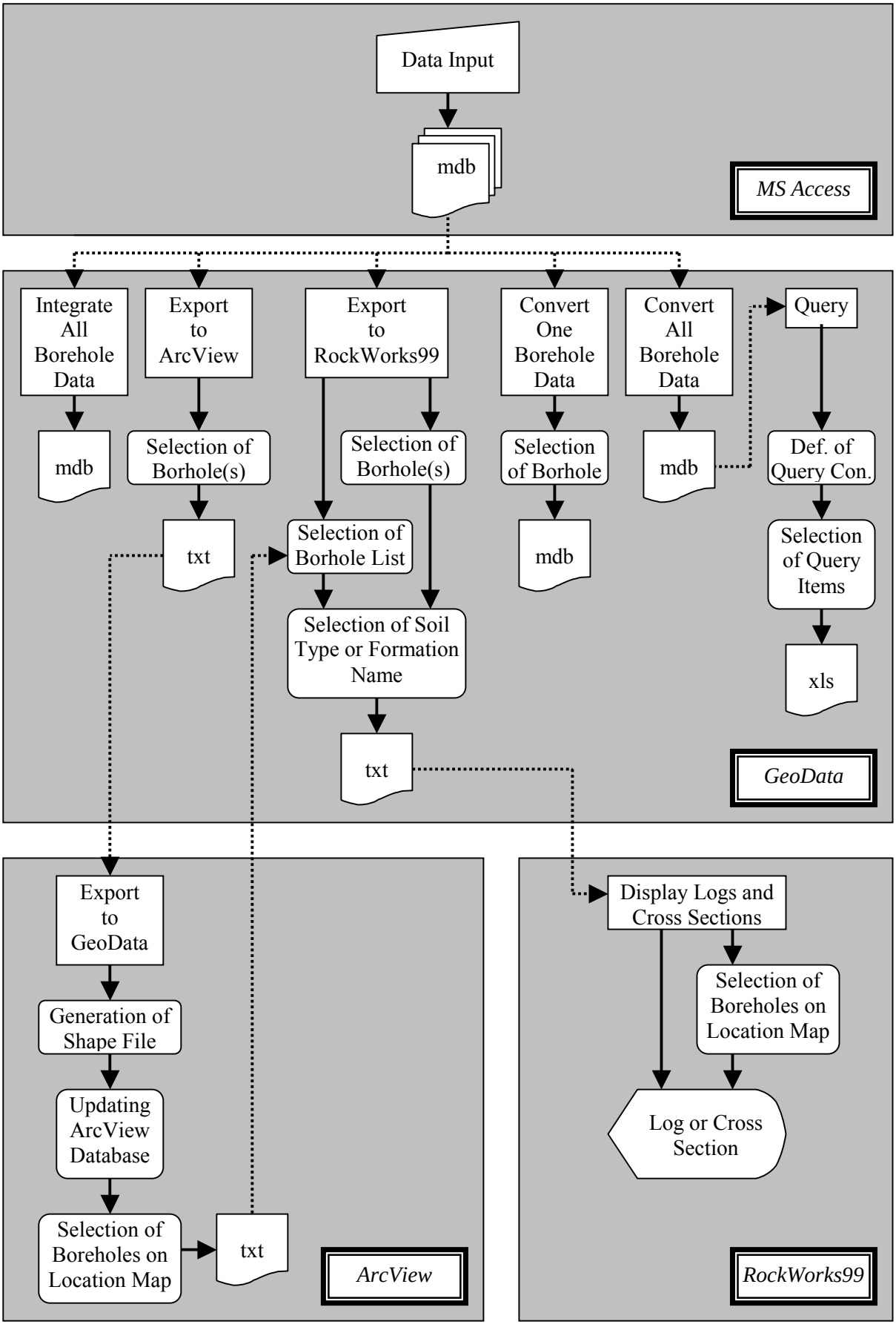


Figure 1. Flow chart of the database.

Plasticity limit (PL) (%)
Plasticity index (PI) (%)
Unit weight (γ_t) (g/cm^3)
Moisture contents (Wn) (%)
Cohesion (C) (kN/m^2)
Angle of friction (ϕ) (degree)

Results of rock laboratory tests

Upper depth of sample (GL-m)
Lower depth of sample (GL-m)
Uniaxial strength (kN/m^2)

Results of PS logging

Lower depth of PS logging (GL-m)
Vs value (ms)
Vp value (ms)

While inputting grain size data, contents and percentage passing values are checked. Sum of gravel, sand and fine contents must be 100, and the relation between D values must be D10<D20<D30<D50<D60.

Number and length of boreholes which are stored in the databases are shown in Table 1.

Table 1. Summary of data input stage.

	Borehole	
	Number	**Length (m)**
European Side	1196	32659.36
Anatolian Side	808	12071.49
TOTAL	2004	44730.85

GeoData has six functions as shown in Figure 1. *integrate all data, export to ArcView, export to RockWorks99, convert one borehole data, convert all borehole data, and query*.

Integrate all data function opens and reads the data stored in all database tables one by one and writes them into " the integrated table" of " the integrated database" which is created beforehand. Integrated table contains only original data; no new or modified data.

In order to export the header information of the boreholes to be represented on the maps in accordance with their coordinates in the ArcView system, *export to ArcView* function is used. After the user selects borehole database files in the borehole folder, header information of them is written in an ASCII file.

The tasks of displaying logs and cross sections are managed in RockWorks99. In general, although displaying procedure is quite easy in RockWorks99, preparing input file is time-consuming because of its specific input file format. In order to facilitate the input process in RockWorks99, *export to RockWorks99* function is developed. The first step is to specify boreholes of which data is exported to RockWorks99. There are two ways for this step: either selecting borehole database files in the borehole folder or selecting text file which is exported from ArcView and contains header information of boreholes selected on the maps. After that the required information is captured from the databases and written in an ASCII file in accordance with RockWorks99 input file format.

Convert One Borehole Data and *Convert All Borehole Data* functions are developed for some statistical reasons. These functions convert borehole data into 1-meter pitch. In other words, values of soil, rock, SPT, disturbed, undisturbed and PS are found out from the original data for every 1 meter depth from zero to total depth. While *Convert One Borehole Data* function works with only one

borehole and the user selects the borehole, *Convert All Borehole Data* function works with all boreholes and the boreholes are selected automatically.

Query is the last function of the system. Queries are performed on the 1m-pitch table of all boreholes, that is the result of *Convert All Borehole Data* function. The first step for the query is the definition of the query conditions. In this step, boundary of the query area that is minimum and maximum values of easting and northing are entered, and soil types (major and detail) and formation are selected in the lists. Contains of the lists are in the following Table 2, 3 and 4, and the user interface image of the query conditions is shown in Figure 2.

Table 2. List of major soil types.

Clay
Fill
Gravel
Organic Soil
Rock
Sand
Silt

Table 3. List of formations.

Antique Fill/Bakırköy	Antique Fill/Güngören
Antique Fill/Güngören/Cf	Antique Fill/Güngören/Trakya
Antique Fill/Trakya	Artificial Fill
Artificial Fill/Bakırköy	Artificial Fill/Bakırköy/Güngören
Artificial Fill/Cf	Artificial Fill/Çamurluhan
Artificial Fill/Güngören	Artificial Fill/Kuşdili
Artificial Fill/Kuşdili/Bakırköy	Artificial Fill/Kuşdili/Trakya
Artificial Fill/Qal	Artificial Fill/Qal/Güngören
Artificial Fill/Qal/Kuşdili	Artificial Fill/Soğucak
Artificial Fill/Trakya	Aydos
Bakırköy	Bakırköy/Cf
Bakırköy/Güngören	Balçık Granite
Baltalimanı	Belgrad
Cf (Ceylan)	Cf/Soğucak
Cf/Trakya	Çamurluhan
Çf (Cukurcesme)	Dolayoba
Fill	Glf
Gözdağ	Güngören
Güngören/Cf	Güngören/Trakya
Gürpınar	Gürpınar/Soğucak
İçerenköy	İkitelli
Kartal	Kırklareli
Kurtköy	Kuşdili
Kuşdili/Bakırköy	Kuşdili/Güngören
Kuşdili/Soğucak	Kuşdili/Trakya
Mlf	Pendik
Qal	Qal/Bakırköy
Qal/Çamurluhan	Qal/Güngören
Qal/Gürpınar	Qal/Soğucak
Soğucak	Soğucak/Trakya
Suleymaniye	Sultanbeyli
Talus	Trakya
Trakya/Dyke	Tuzla

Table 4. List of detail soil types.

Alluvial Deposit	Altered Graywacke	Altered Siltstone
Andesite	Andesite Diabase	Andesite Dyke
Argillaceous Limestone	Arkose	Arkose Claystone Siltstone
Arkose Sandstone	Arkose Sandstone Siltstone	Arkose Siltstone Sandstone
Artificial Fill	Bedrock	Block
Carbonated Slate	CE	CH
CH/CI	CH/SM	CH-CE
CH-MH	CI-CL	CI-SM
CL	Clay	Claystone
Claystone Limestone	Claystone Marl	Claystone Mudstone
Claystone Sandstone	Claystone Sandstone Siltst.	Claystone Shale
Claystone Siltstone	Clst. Sltst. Graywacke	Clst. Slst. Graywacke Diabase Dyke
Claystone Slst. Sandstone	CL-GC	CL-ML
CL-SM	C-M	C-M-S
Conglomerate	Cort	Crushed Zone
C-S	C-S-G	CV
CV-CE	CV-CI	Diabase
Diabase Dyke	Dolorite	Fill
FL-SC-GC	GC	GC-CL
GL	GL-ML	GM
G-M	GP	GP-GC
GP-GM	GP-SP	Granite
Gravel	Graywacke	Graywacke Sandstone Graywacke
G-S	G-S-C	Limestone
Limestone Block	Limestone Marl	Limestone Sandstone
Limestone Siltstone	Limstone	Loose Mud
Made Ground	Marl	Marl Limestone
M-C	MH	MH-CH
Micaleous Graywacke	Micaleous Sandstone	ML
ML-CL	ML-SM	M-S
M-S-C-G	Mud	Mudstone
Mudstone Claystone	Nodular Limestone	OH
OL/OH	Organic Soil	Quartarenite
Quartzite	Quartzite Sandstone	Rock
Rock	Sand	Sandstone
Sandstone Claystone	Sandstone Claystone Slst.	Sandstone Graywacke
Sandstone Limestone Block	Sandstone Mudstone	Sandstone Mudstone Shale
Sandstone Shale	Sandstone Shale Mudstone	Sandstone Siltstone
Sandstone Siltstone Clst.	Sandstone Slate	SC
S-C	S-C-G	SC-GC
S-G	S-G-C	SH
Shale	Shale Graywacke	Shale Sandstone
Shell	Shell Accumulation	Shist
Siliceous Shale	Silt	Siltstone
Siltstone Claystone	Siltstone Graywacke	Siltstone Sandstone
Slate	SM	S-M
SM/SP	S-M-C	SM-GM
SM-GP	SM-SC	SM-SP
SP	SP-GP	SP-SM
SW-SC	Top Soil	Tracyandesite Dyke
Tuff	Void	Volkanic Rock
Weathered Rock	Weathered Rock Zone	Weathered Zone
Weathered Zone Limestone		

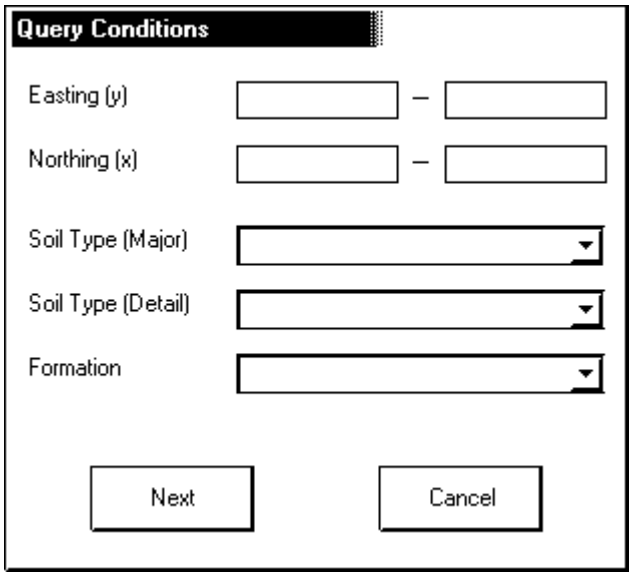


Figure 2. User interface image of query conditions.

The last step for the query is the selection of two items in the listing containing soil and laboratory test types and PS loggings. User interface image of query items is shown in Figure 3.

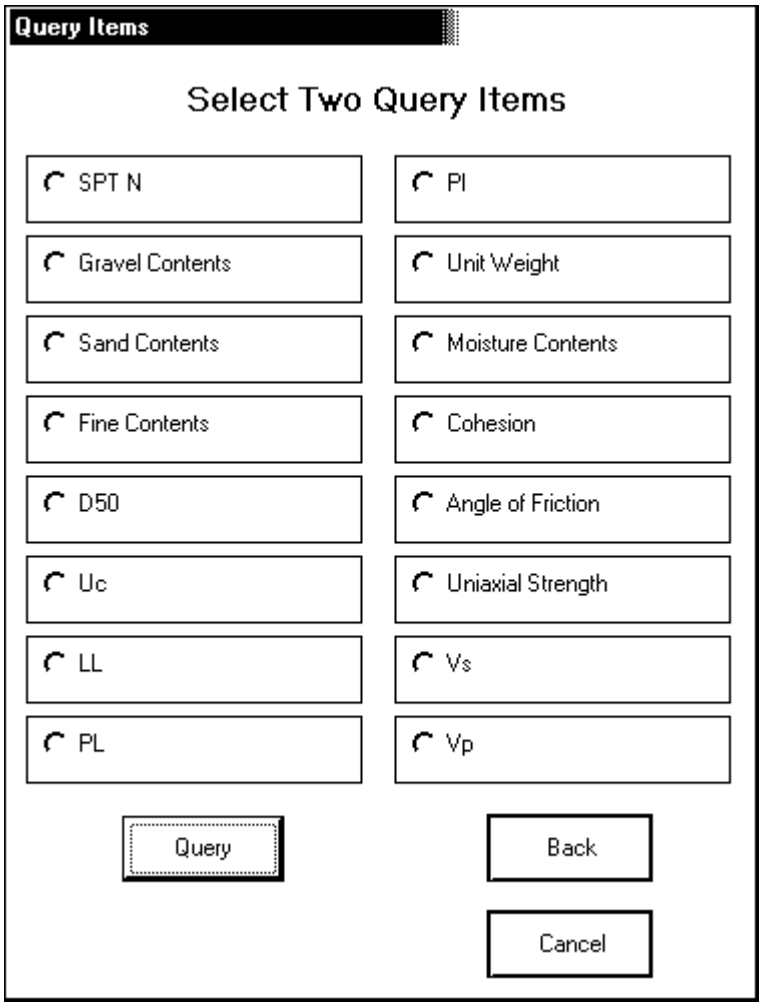


Figure 3. User interface image of query items.

In this project, RockWorks99 is used for displaying logs and cross-sections. RockWorks99 is a useful program in geological and geotechnical studies but has a handicap. Its input file format is quite specific. Soil type or formation data to be displayed in logs or cross sections must be listed from left to right in order of decreasing elevation. Another restriction is about column number. The program lets enter up to 49 columns of data. Therefore a function named *export to RockWorks99* is added to GeoData. In RockWorks99, firstly the text file exported from GeoData is imported and than a log can be displayed easily and directly or a cross section can be created after the boreholes are selected on the location map.

The last part of this system is ArcView. It is used for facilitating of borehole selection step while exporting data to RockWorks99 in GeoData because selection of related boreholes in the borehole folder, which contains about 2000 boreholes for the present, may be difficult and time consuming. In ArcView, according to the header information in the text file exported from GeoData, boreholes are represented on the location map and the ArcView database is updated. After that the user can easily select boreholes on the map and a text file containing header information of the selected boreholes is prepared automatically by means of a script.

3 CONCLUSION

In this system, borehole data is stored in digital environment in a unique format. Therefore, the problems related to the classic archives are solved. For example, boreholes will not be lost any longer and the time needed for reaching borehole data will be minimum. Furthermore, borehole data in the system is comprehensible and useful because of the unique format. Lastly it is possible to make some queries on the data and get results for geological and geotechnical analysis works.

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